

Business Intelligence 2.0: a General Overview

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- Introduction
- BI & Data Warehouses in a Nutshell
- Basic Concepts related to BI 2.0
- Influence from the Web on BI
- Technical Challenges of the new BI 2.0
- General Overview of Tools Stepping Towards BI 2.0
- Conclusions

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Introduction

- The use of Business Intelligence solutions has been steadily **increasing**
 - In the recession period, the BI market grew 4%
- BI allows the business to gain a **competitive edge** by analyzing the data of the organization

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Introduction

- Traditional technologies to support BI processes range from **Data warehouses** to **OLAP** and **Data mining**.
 - These technologies allow to query the organization's **internal** data
- However, a new trend has emerged: analyzing data from **outside** the organization.

Introduction

- For example, including information like:
 - Retail prices of products sold by competitors
 - Opinions from customers
 - ...
- Result: **Richer** analysis and **better support** for the decision-making process

Introduction

- However this trend is **bidirectional**
 - As BI applications **include information from the Web,**
 - These applications have also been **evolving towards web technologies.**

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Introduction

- Evolution driven by technologies appeared in the Web 2.0:
 - Social Networks (e.g. Facebook)
 - Graph and linked data
 - Interactive Web applications
 - Cloud computing
 - Collaborative Networks
 - Process Intelligence
 - Software as a Service...



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Introduction

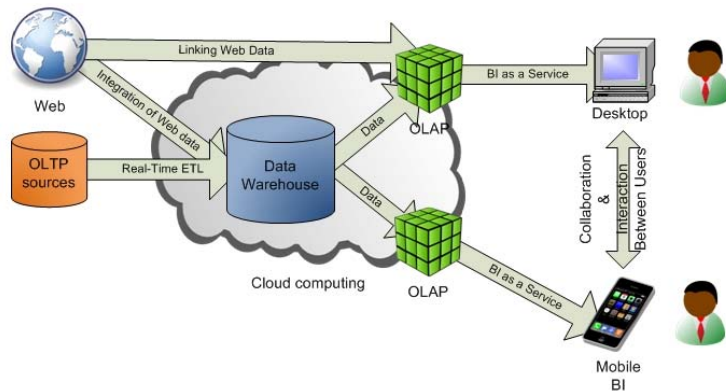
- Some authors call it BI 2.0, others BI 3.0...
 - Which are the common aspects that define the new BI?
- How is the web affecting BI and which **new features** are being included from this influence?

Introduction

- Which **technical challenges** must be overcome?
 - Which are already solved, which require further research?
- Which features are being integrated by **BI tools**?

Introduction

- A first look into a BI 2.0 architecture...



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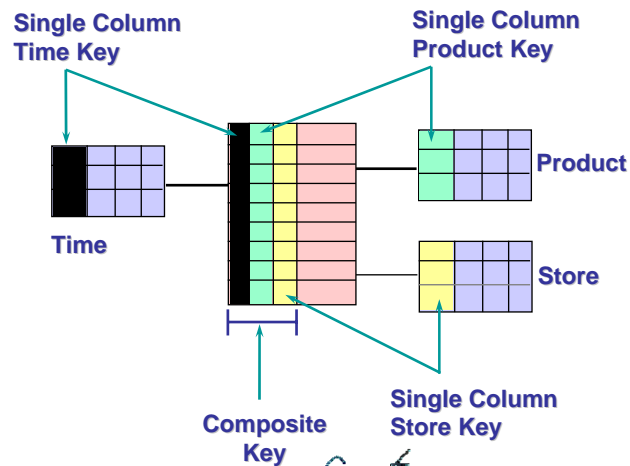
BI & Data Warehouses in a Nutshell

- Traditionally, BI has focused on analyzing huge amounts of data to support the decision-making process
- Transactional databases are not adequate for this task:
 - Difficult to retrieve the necessary information
 - Performance

BI & Data Warehouses in a Nutshell

- Necessary to develop the decisional database with an alternative design:
 - Focus on the information being analyzed
 - Improving the performance
- Result:
 - Vendors implement the logical models Star Schema, Snowflake, Fact Constellation,...
 - [Kimball, 96]

BI & Data Warehouses in a Nutshell



BI & Data Warehouses in a Nutshell

- However, as the logical model is designed to store data and improve performance:
 - It does not take into account analysts' needs
 - Schema is still difficult to understand
 - Difficult to retrieve information (SQL queries over the database)

BI & Data Warehouses in a Nutshell

- The logical level lacks detail to specify multidimensional information
- It is necessary to create models with a higher abstraction level: **conceptual models**

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BI & Data Warehouses in a Nutshell

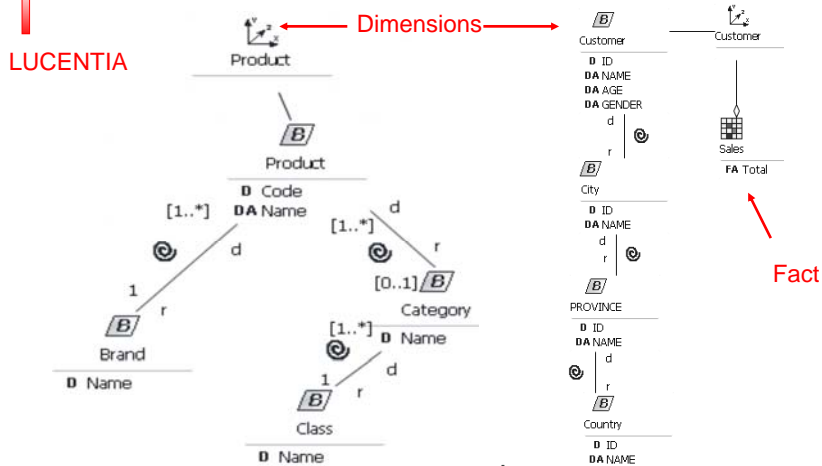
- Different **conceptual** models have been proposed to solve this issue within data-driven approaches

[Abelló et al. 2006][Trujillo et al., 2001][Luján-Mora et al. 2006][Sapia et al. 2004][Tryfona et al. 1999] [Golfarelli et al. 99] and many more

- Unfortunately, up now none has been accepted as a **standard**
 - Although supported by tools and checked in real-world projects

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BI & Data Warehouses in a Nutshell



BI & Data Warehouses in a Nutshell

- Is the multidimensional information **not relevant**?
 - No, BI tools have also implemented **their own representations**
 - Information related to facts, dimensions, and hierarchies is **highly relevant** for the analysis
 - Moreover, it enables to query the DW using **OLAP** and **MDX queries**

BI & Data Warehouses in a Nutshell

- Nevertheless, being able to query the DW does not mean that it satisfies user's needs
- Solution? Perform a **requirements analysis stage** to design the DW
 - Using a higher abstraction level to communicate with users

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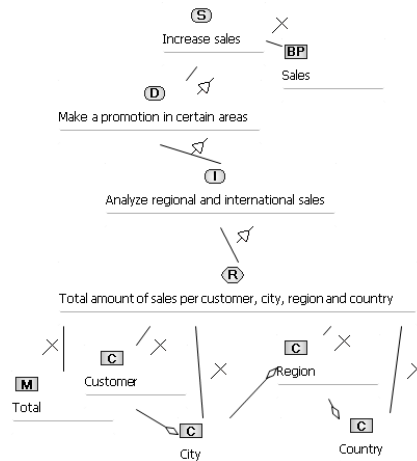
BI & Data Warehouses in a Nutshell

- As previously, there is currently **no standard** for the Requirements Engineering (RE) stage
[Giorgini, Golfarelli, Rizzi, 2008][Mazón et al. 2007]
- However, the RE stage allows us to **identify and guarantee** that the **analysts' needs are met**

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BI & Data Warehouses in a Nutshell

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User's
Requirements
Approach

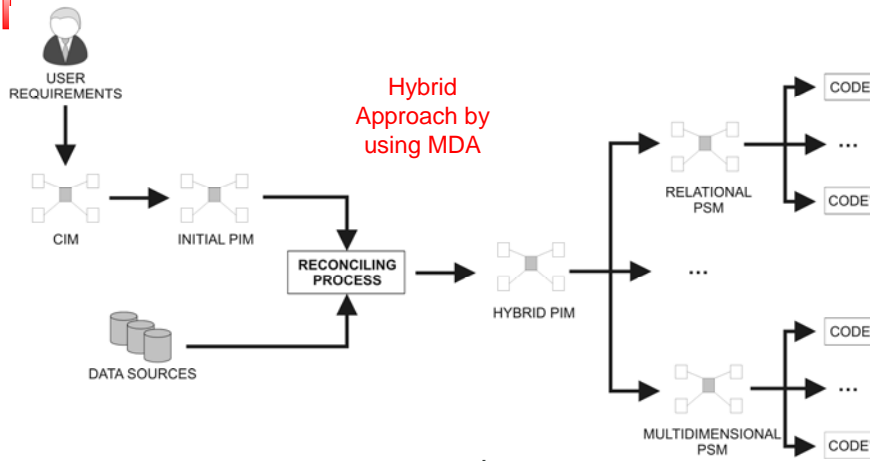
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BI & Data Warehouses in a Nutshell

- A complete hybrid DW development approach has been proposed in the **Lucentia** Research Group
[Trujillo et al., 2001] [Mazón et al. 2008][Mazón et al. 2009]
- Considers both user requirements and data sources
- **Hybrid** approaches allow us to identify problems in early stages

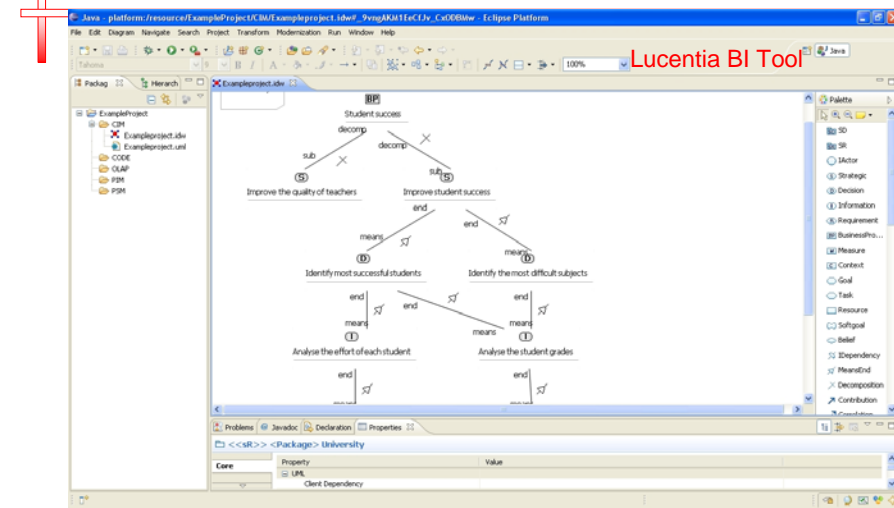
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BI & Data Warehouses in a Nutshell



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BI & Data Warehouses in a Nutshell



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BI & Data Warehouses in a Nutshell

- Since there is a proposal for automatically deriving DWs, has **every problem been solved** in this area?
 - No. There are a series of **challenges still open**
 - **Traceability** of user's requirements
 - Quality measures to drive the design
 - Security constraint from the early stages
 - And many more

BI & Data Warehouses in a Nutshell

- Business processes **evolve**, therefore the DW must support this evolution
- We require to **analyze information present in the Web**
 - This information is typically **unstructured**
 - Accuracy and correctness are not guaranteed

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Basic Concepts related to BI 2.0

- When talking about BI 2.0 it is important to define some **basic concepts**
- **Real-time**
[Thiele et al. In Press], ...
 - All the information used must be fresh and up-to-date
 - Exceptional situations previously unknown
 - E.g. Sales data without the list of products

Basic Concepts related to BI 2.0

■ Cloud computing

[Armbrust et al. 2009], [Larry Ellison, Wikipedia]

- Integration of several, heterogeneous elements into a network
- Middleware provides homogeneous interface
 - Services provided consumed through SaaS
- Supports the addition of new elements

Basic Concepts related to BI 2.0

■ Collective Intelligence

[Gruber et al. 2008]



- Originally refers to emerging behaviours
 - E.g. Ant colonies can solve the *Travelling Salesman Problem*
- Social Networks also present emerging behaviours
 - Decentralized groups are able to take decisions as a group and promote initiatives

Basic Concepts related to BI 2.0

■ Crowdsourcing

[Howe et al. 2009]

- Delegating a task to a crowd
 - e.g. Mechanical Turk services in Amazon
- Each individual contributes with a **little effort** to the global goal
- Depending on how the crowd is **organized**, the **collective intelligence** can achieve **better solutions** than a single expert

Basic Concepts related to BI 2.0

■ Social Networks

[Berthold et al. In Press][Golfarelli et al. In Press]



- Group of participants which can **interact** with each other
 - Typically they collaborate, achieving goals **faster** and with **better results** than a single individual would
- The most relevant data are the **contributions from the participants** and the **relationships** between them

Basic Concepts related to BI 2.0

▪ Linked Data

[Berlanga et al. In Press] [Bizer et al. 2009]

- Knowing the **relationships** between each piece of data and the rest
- In order to be able to reason and infer knowledge, the relationships must be **semantically tagged**
- Allows to obtain knowledge **automatically**

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Basic Concepts related to BI 2.0

▪ Opinion mining

[Balahur et al. In Press]

- Describing the **general feelings** of a group of **people** towards a certain **element**
- Requires to **analyze** unstructured data, **understand** its content and obtain a **conclusion**
- Highly **relevant** to identify **how customers perceive products**

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Basic Concepts related to BI 2.0

- Process Oriented BI

[Golfarelli et al. 2004]

- Point of view focused on Business processes and their logic
- Tries to relate the stored data to the process performance
 - Extensions of BPMN 2.0
- Allows to identify and restructure business processes presenting problems

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Influence from the Web on BI

- As society evolves, the ratio of connectivity has increased
- The business environment is rapidly changing
- Physical barriers disappear
 - Business provide their services online

Influence from the Web on BI

- Customers can access a wide variety of offers with no additional cost
 - The customer becomes more critic
- New technologies allow customers to interchange opinions
 - Social Networks, Twitter, online reviews...
 - Customers influence other customers

Influence from the Web on BI

- Businesses need to consider **as much information as possible** when taking decisions
 - What do the competitors offer?
 - What do our customers think about our products?
- Decisions must be **agile**
 - Otherwise, customers will **leave**



Influence from the Web on BI

- How is BI and BI tools being **altered** by this new **dynamic environment**?
 - New interfaces
 - Using always fresh, up-to-date information
 - Decisions are no longer isolated
 - Data is presented in a more significant manner
 - Focus on analyzing the immediate future

Influence from the Web on BI

- New interfaces
 - New requirement introduced: data must be checked from *anywhere*
 - *Web interfaces* replace desktop applications
 - Introduction of *Mobile BI*

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Influence from the Web on BI

- Mobile BI
 - Accessing data using *mobile devices*
 - Limitations in screen size and memory
 - Transfer only the *necessary data*
 - Show only the *necessary information*
 - Navigation must be *interactive* and *simple*



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Influence from the Web on BI

- Up-to-date periods
 - Traditionally information was provided in the form of reports
 - However, currently reports are **only checked** to identify the source of an **existing** problem
 - They are not interactive, and **difficult to relate to business goals**
 - The information provided by reports arrives **too late**



Influence from the Web on BI

- Is monthly or weekly information **fresh enough**?
- In order to answer this question let us consider an **example**:
 - After the recent security breaches in Sony, **how much time** was required for its image to be hurt in **the whole world**?
 - Under a **day**

Influence from the Web on BI

- Decisions are no longer isolated

[Berthold et al. In Press][Golfarelli et al. In Press]



- Traditionally, decisions would be taken by **executives** in an **isolated** manner
- However, it has been proposed that it is better to take decisions using **collective intelligence** or even **crowdsourcing**
- Often, employees have **relevant knowledge** regarding a specific problem

Influence from the Web on BI

- Two main alternatives for taking decisions in group:
 - **Discuss** the decision through collaborative BI with other employees (i.e. interacting like in a Social Network)
 - Allow employees to **enrich the existing data** and **contribute** with their own information
 - Then, **exploit** this information in order to take a decision

Influence from the Web on BI

- In order to achieve these **collective decisions**, data should be **interactive**
 - Users should be able to **easily interchange information**
 - Did you know that **Excel** is the **3rd most used BI tool** in Spain?
[Pentoo 2011]
 - Users should be able to make annotations and **enrich the data with relevant information**

Influence from the Web on BI

- Data is presented in a **significant way**
 - Traditionally, and currently by default, tools focus on **how** to present aggregated data
 - Bar graphs, spreadsheets, stacked bars...
 - However, decision-makers wish to use the data to **identify** which **strategies** are **working** and which ones are not


Influence from the Web on BI

- Tendency:
 - Relate the data to **balanced scorecards** by means of dashboards
 - Allows us to easily identify the status of our business strategy
 - Other proposals relate data directly to **business goal models** or to **business process models**

Influence from the Web on BI

- New focus of analysis
 - Long-term decisions are **still important**
 - However, due to the **dynamic environment** there is a new necessity to focus on the **immediate future**
 - Apparition of problems which require **immediate attention**
 - **Still more visualization is needed**

Influence from the Web on BI

- Increasing number of short-term decisions 
 - These decisions require real-time information
 - i.e. Do I need to restock my products to meet the demand for the rest of the day?
 - Reliance on predictive data mining, with a strong time restriction

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Technical Challenges of the new BI 2.0

- The new aspects envisioned for BI 2.0 cannot be accomplished unless we overcome a series of technological challenges
- Some of these challenges have already been thoroughly studied while others are still open for further research

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Technical Challenges of the new BI 2.0

- Making a brief review we require:
 - Support for real-time data
 - Scalable architecture for multiple collaborating users accessing the DW
 - Include Web data into the analysis
 - Provide predictive algorithms to analyze the information
 - Analyze and relate business processes to the stored data
 - Establish semantic relationships between data in order to automatically infer knowledge (linked data)

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Technical Challenges of the new BI 2.0

- Real-time Data Warehouses
 - Real-time Data Warehouses have been the focus of research in the past years
 - The most significant difference between traditional and real-time DW is how data is captured

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Technical Challenges of the new BI 2.0

- Real-time Data Warehouses
 - Traditionally, data is captured in operational databases when a transaction is processed
 - Then, at some point defined by the refreshing cycle, all the new data is loaded through ETL processes
 - This process is known as bulk-feed

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Technical Challenges of the new BI 2.0

- Real-time Data Warehouses
 - Bulk-feed has several drawbacks:
 - Negative impact on performance of both operational and decisional databases
 - The DW does not have the most up-to-date data
 - Solution?
 - Alter the way of capturing data
 - Obtain the information simultaneously as it is stored in transactional databases (trickle-feed)

Technical Challenges of the new BI 2.0

- Real-time Data Warehouses
 - In order to load transactions into the DW as they are captured we can:
 - Use triggers in transactional databases
 - Extract the information from logs
 - Use replication techniques
 - The ETL process is transformed into a modeled parallel flow of data towards the DW
 - Information may be incomplete at certain points
 - Important to model unexpected flows (exceptions)

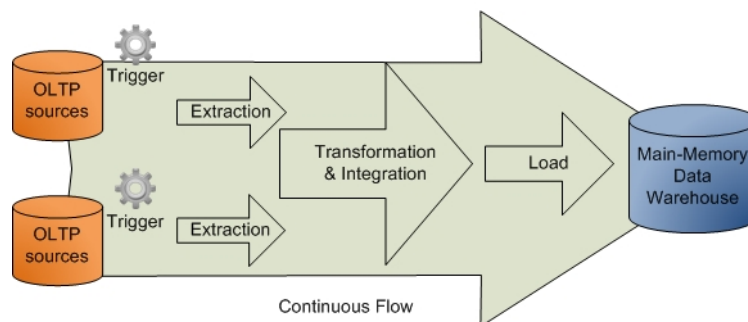
Technical Challenges of the new BI 2.0

- Real-time Data Warehouses
 - Finally, as queries must be processed **simultaneously** as data is being loaded we need to consider:
 - **Minimizing query delay** by using parallelization or main-memory databases
 - Using replicated tables, in order to guarantee the **correctness** of the analysis
 - These tables can be swapped in short cycles

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Technical Challenges of the new BI 2.0

- Real-time Data Warehouses



- More in Dagstuhl seminar: Real Time DWs

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Technical Challenges of the new BI 2.0

■ Scalability

- BI 2.0 envisages constant real-time data flows into the DW
- Number of users querying the DW is also expected to increase
- The scalability of the system becomes an important factor

Technical Challenges of the new BI 2.0

■ Scalability

- How can we increase the scalability of the BI system?
 - How can we increase the scalability of a system in general?
 - More powerful single pieces of hardware
 - More hardware elements
 - How does this translate into BI?

Technical Challenges of the new BI 2.0

■ Scalability

- First option: More powerful pieces of single hardware
 - In BI this means better dedicated servers
 - Exadata (Oracle)
 - TwinFin (Netezza)
 - Information is stored by the organization
 - Potentially more secure
 - Privacy



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Technical Challenges of the new BI 2.0

■ Scalability

- Second option: Simply more hardware
 - The recent apparition of cloud services allows us to create a flexible system
 - Use more power as you need
 - Pay-as-go
 - Two approaches:
 - Public Clouds (i.e. Amazon, Azure Cloud, iCloud)
 - Private Clouds (with your own high-end servers!)

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Technical Challenges of the new BI 2.0

- Processing semi-structured and unstructured data
 - Highly relevant information is posted online
 - Customers' opinions
 - Retail prices from competitors
 - Reviews of products
 - However, this information is not structured

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Technical Challenges of the new BI 2.0

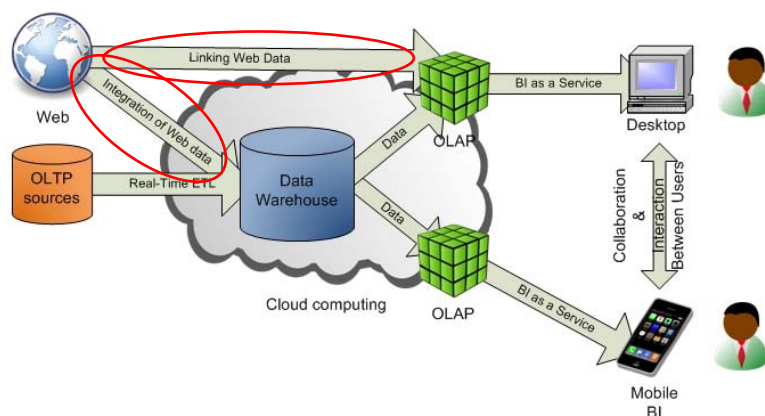
- Processing semi-structured and unstructured data
 - Two different situations:
 - Semi-structured data (XML)
 - Presents some basic structure
 - The structure helps in interpreting and integrating the data into the system
 - Unstructured data
 - NLP
 - Is Hadoop the right solution ?

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Technical Challenges of the new BI 2.0

- Processing semi-structured and unstructured data
 - How to include the web information into the BI System?
 - Integrate this information into the **enterprise DW**
 - Correctness of the data inside the DW will **not be guaranteed!!**
 - Create a **separate DW** for Web information
 - Link this information as a **detailed view** after generating the analysis cube

Technical Challenges of the new BI 2.0



Technical Challenges of the new BI 2.0

- Predictive data mining algorithms
 - As the focus of analysis shifts towards the immediate future, the importance of predictive analysis increases
 - Descriptive techniques are pushed into the background
 - Historic information and classifications are still important but not the focus

Technical Challenges of the new BI 2.0

- Predictive data mining algorithms
 - It is necessary to predict what will happen in the immediate future
 - A number of existing predictive techniques already exist
 - However, they have not been designed to fulfill the current needs in BI 2.0

Technical Challenges of the new BI 2.0

- Predictive data mining algorithms
 - Huge amounts of data are required to take a decision
 - This situation requires automatic analysis
- Strong time constraints
 - The result must be provided to solve a short-term problem
 - We need an answer, even if it is not the *best answer*



Technical Challenges of the new BI 2.0

- Analyzing business processes
 - Business processes are gaining increased attention from the research community
 - By modeling business processes, we are able to identify the flow of data through the business activity

Technical Challenges of the new BI 2.0

- Analyzing business processes
 - Advantages of modeling business processes:
 - Easier to understand the business activity
 - Identification of deadlocks
 - Allow us to perform Business Process Intelligence
 - Which steps in the process are not working as intended
 - Which processes should be remodeled

Technical Challenges of the new BI 2.0

- Analyzing business processes
 - Challenges:
 - Business process models lack information about the structure of the underlying data
 - Necessary to relate the existing data with business process models in order to analyze them

Technical Challenges of the new BI 2.0

■ Linking data

- As we have previously seen, the **most important feature** of a piece of data in BI, is its **relationships** with other pieces of data
 - Relationships allow us to **reason** and **inere knowledge**
- There are different kinds of relationships
 - Some are **explicitly** modeled
 - Some are **implicit** in the data

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Technical Challenges of the new BI 2.0

■ Linking data

- **Explicit relationships:**
 - Explicit relationships are those **already modeled** in the system
 - i.e. Facts and Dimensions
 - They are the basis for **analysis** and **structuring** the information

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Technical Challenges of the new BI 2.0

- Linking data
 - Implicit relationships:
 - Although not explicitly modeled, **implicit correlations** between data can be **discovered**
 - Data mining, artificial intelligence can help to identify these relationships
 - However, they require that all the information is **included** and **related** in the analysis

Technical Challenges of the new BI 2.0

- Linking data
 - What about the analysis of **different sets** of data?
 - e.g. Decrease in sales in our products related to an increase in sales from our competitors
 - Unless these sets are **not joined** in a single analysis, this information will **not be identified**
 - However, we cannot join **all** the information to perform a **single** analysis of the **whole system**

Technical Challenges of the new BI 2.0

- Linking data
 - Nevertheless, if the important relationships are identified and modeled, new knowledge can be inferred
 - Ontologies for modeling the domain
 - Preserving the existing relationships using traceability
 - Domain-dependent
 - It is important to include meaningful semantics for the analysis

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General Overview of Tools Stepping Towards BI 2.0

- How are BI vendor tools integrating BI 2.0 features?
- Which features are better supported?
- Which ones are most lacking?

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General Overview of Tools Stepping Towards BI 2.0

- Brief analysis of tools to provide an overview
 - Microstrategy
 - Pentaho
 - Cognos
 - SAS
 - Microsoft
 - SAP

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General Overview of Tools Stepping Towards BI 2.0

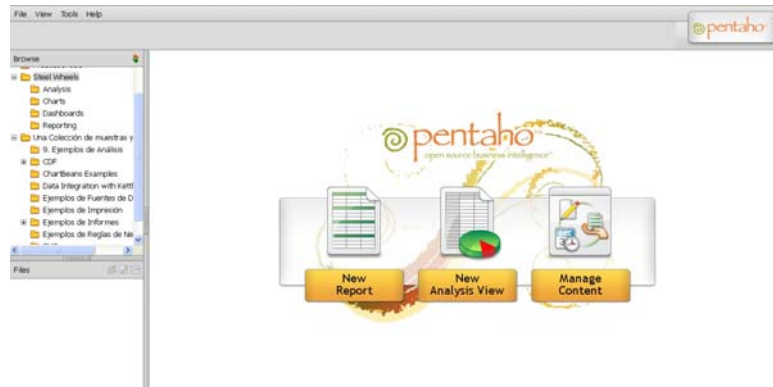
- Microstrategy
 - Positive aspects:
 - **Web interface**. Includes dedicated **Mobile BI** support
 - **Scorecards** and **Dashboards** connecting Key Performance Indicators (KPI) to **provide visibility**
 - Limitations:
 - **Limited predictive analysis** support
 - Interaction and **collaboration** between users?
 - Integration of **business processes**?

General Overview of Tools Stepping Towards BI 2.0

- Pentaho
 - Positive aspects:
 - **Open source**, multi-platform, **Web interface**
 - Includes **Dashboards** for presenting linked data
 - Some **predictive algorithms** included
 - Includes some **collaborative features** when integrated with LifeRay
 - Limitations:
 - Designing and integrating **dashboards** requires some effort
 - Interactivity and **data enrichment**?
 - Integration of **business processes**?

General Overview of Tools Stepping Towards BI 2.0

- Example of a BI web interface (Pentaho)



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General Overview of Tools Stepping Towards BI 2.0

- Cognos (IBM)
 - Positive aspects:
 - Web interface. Support for Mobile BI
 - Dashboards and Scorecards
 - Collaborative support and data enrichment with annotations
 - Limitations:
 - Predictive analysis support?
 - Business processes?

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General Overview of Tools Stepping Towards BI 2.0

- SAS:
 - Positive aspects:
 - Web interface. Support for Mobile BI
 - Highly customizable Dashboards
 - Allows linking elements
 - Special visualization tools
 - Limitations:
 - Predictive analysis?
 - Collaborative BI?
 - Business processes?

General Overview of Tools Stepping Towards BI 2.0

- Microsoft BI:
 - Integration of several tools:
 - Excel
 - PowerPivot
 - SQL Server
 - Sharepoint

General Overview of Tools Stepping Towards BI 2.0

- Microsoft BI:
 - Positive aspects:
 - Web interface
 - Dashboards and Scorecards through mashups
 - Allows to link elements and interact with other users
 - Supports adding tags to our profile in sharepoint
 - Analysis through Excel and PowerPivot
 - Allows to include data from the Web

General Overview of Tools Stepping Towards BI 2.0

- Microsoft BI:
 - Limitations:
 - Additional effort to use different technologies at the same time
 - Predictive analysis limited to Excel functions
 - Lacks some collaborative functions
 - Direct interaction between users
 - Adding annotations to the data, so other BI users can see them

General Overview of Tools Stepping Towards BI 2.0

- SAP:
 - As in the previous case, composed of various tools
 - Provides complete support for analyzing the business strategy combining desktop applications with web applications

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General Overview of Tools Stepping Towards BI 2.0

- SAP:
 - Positive aspects:
 - Web interface for ad-hoc analysis. Includes Mobile BI support
 - Dashboards and scorecards
 - Complete workbench for data mining tasks
 - Compatibility with other vendors tools, empowering analysis capabilities
 - Excel
 - Enterprise applications

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General Overview of Tools

Stepping Towards BI 2.0

- SAP:
 - Limitations:
 - The **collaboration** between users is limited
 - Lacks support for **enriching data**
 - **Interaction** between users is not integrated in the system
 - These aspects are being **improved**

General Overview of Tools

Stepping Towards BI 2.0

- Final considerations:
 - Most tools support **cloud computing** using a **SaaS** or **BI as service** approach
 - Some tools include support for using the **cloud** in specific tasks
 - Cognos: Guide to deploy the system
 - Microsoft: Deploying the system into Azure Cloud
 - Pentaho: Data Integration in the cloud

General Overview of Tools Stepping Towards BI 2.0

- Final considerations:
 - Visibility of the business strategy is provided mainly by using **Dashboards**
 - Requires some **effort** to build the desired dashboard and it is **not always intuitive**
 - Could be **improved** by adding support for building the dashboard in an **interactive way**
 - Collaborative aspects are **limited**

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Conclusions

- BI 2.0 has to deal with several aspects:
 - Real-time analysis
 - Intuitive and interactive analysis from anywhere
 - Collaboration between decision-makers
 - Linking and enriching data
 - Focusing on the immediate future
 - ...

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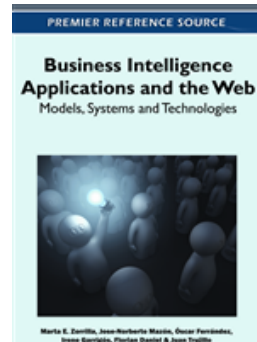
Conclusions

- Further research needs to be done in:
 - Predictive algorithms with strong time restrictions
 - Identify the most effective way of presenting the data
 - Develop a series of best practices when taking decisions in a collaborative manner
 - Process Intelligence and Process Mining
 - ...

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Conclusions

- Further research needs to be done in BI:



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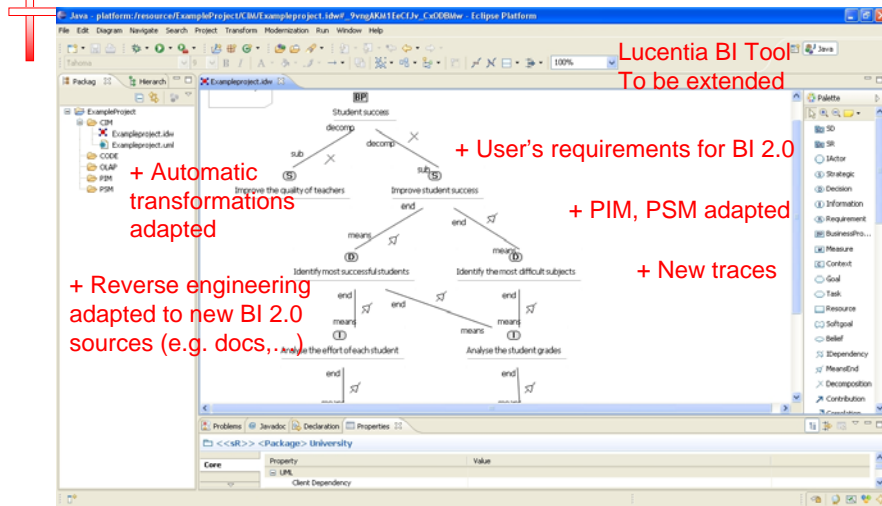
Conclusions

- In our Lucentia Research Group:
 - **Process Intelligence**
 - Mining processes
 - Linking processes to data from BPMN 2.0
 - **Traceability** of user's requirements
 - **BI 2.0 security and quality**
 - **Web Warehouses**
 - Advanced **visualization** techniques
 - More:
 - <http://www.lucentia.es>
 - Recent publications on DB&LP

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Conclusions



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Business Intelligence 2.0: a General Overview

THANK YOU. QUESTIONS?

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